SUBLIMATION: A MECHANISM FOR THE ENRICHMENT OF ORGANICS IN ANTARCTIC ICE. L. Becker[1], G. D. McDonald[2], D. P. Glavin[1], J. L. Bada[1], and T. E. Bunch[3], [1]Scripps Institution of Oceanography, La Jolla CA 92093-0212, USA, [2]Laboratory of Planetary Studies, Cornell University, Ithaca NY 14853, USA, [3]NASA Ames Research Center, Moffet Field CA 94035-1000, USA.

Recent analyses of the carbonate globules present in the Martian meteorite ALH 84001 have detected polycyclic aromatic hydrocarbons (PAHs) at the ppm level [1]. The distribution of PAHs observed in ALH 84001 was interpreted as being inconsistent with a terrestrial origin and were claimed to be indigenous to the meteorite, perhaps derived from an ancient Martian biota. However, Becker et al., [2] have examined PAHs in the Martian meteorite EETA 79001, in several Antarctic carbonaceous chondrites and Antarctic Allan Hills Ice and detected many of the same PAHs found in ALH 84001. The reported presence of L-amino acids of apparent terrestrial origin in the EETA 79001 druse material [3], suggests that this meteorite is contaminated with terrestrial/extraterrestrial organics probably derived from Antarctic ice meltwater that had percolated through the meteorite.

The detection of PAHs and L-amino acids in these martian meteorites suggests that despite storage in the Antarctic ice, selective changes of certain chemical and mineralogical phases has occurred [2–5]. How do the organic components in these meteorites, which show little physical evidence of weathering become altered? Ordinarily, a meteorite that falls on Antarctica becomes buried in the snow, incorporated into the ice, carried to the edge of the continent and discharged into the sea [6]. In some areas, however, the ice does not reach the sea but rather sublimates or ablates at the surface exposing the meteorites. These meteorites collect on the ice sheet where they are joined by direct falls, the influx of cosmic dust (e.g., interplanetary dust particles, micrometeorites, etc.) [7,8] and aerosols (e.g., terrestrial particulates, marine, crustal rocks, soot, etc.) [9,10].

In the case of Allan Hills, the rate of ice ablation is almost entirely due to sublimation driven by dry katabatic winds from the interior of the continent [11]. A study of the effects of sublimation and ablation in Allan Hills ice found that the rate of sublimation/ablation varied from 1.1 cm/yr to 7 cm/yr [12] depending on the type of location. For example, a location on the firn had almost identical accumulation to ablation and sublimation rates (0.8 cm/yr vs. 1.1 cm/yr) while a location on bare ice was dominated by ablation and sublimation (0.8 cm/yr vs. 7.0 cm/yr).

This brings up an interesting point about the accumulation and concentration of organics in meteorites recovered from the Antarctic icesheet. If the ablation rate is taken to be 5 cm/yr, then a cubic volume of ice, 10 cm on each side (1 l), will be reduced by 50% per year. This would result in a two-fold concentration every other year of any involatile material present in the ice. Wright et al., [13] have suggested that, in order for meltwater-borne amino acids to account for the levels detected in the EETA 79001 [3], some 3 to 8 $\times$ 10^6 ml (3000–8000 l) of meltwater would have to be percolated through the meteorite during its residence time (11,000 yr) on the Antarctic icesheet. Ablation and sublimation over this time period, however, would have concentrated the organics in the ice surrounding the meteorite by a factor of roughly 5500! Therefore, a volume of meltwater of only 0.545–1.454 l would be necessary to account for the observed minimum concentrations detected in this meteorite (~ 0.4–1 ppm). Even if EETA 79001 was only exposed at the surface for 5000 yr, the minimum estimated surface weathering time for an Antarctic meteorite [14] the meltwater volume required would only be some 1.2–3.2 l, not an unreasonable amount of water to percolate through 7-9 kg of rock over a few thousand years. Thus, sublimation is an efficient mechanism for concentration of organics in Antarctic ice meltwater which, in turn, can infiltrate Antarctic meteorites.

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